

## BRIEF PAPERS

### VITAMIN C CONCENTRATION IN DEVELOPING AND MATURE FRUITS OF MANGO (*MANGIFERA INDICA* L.)<sup>1</sup>

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The mango (*Mangifera indica* L.) is an important tropical fruit, certain varieties of which have found increasing favor in temperate regions as dessert fruits. Previous studies have given the vitamin C (ascorbic acid) content of mature fruits from many varieties (5, 6, 7) as well as the distribution of vitamin C in the flesh (7). Although data from numerous other fruits are available, the seasonal pattern of vitamin C development in mangoes has not been reported, nor have analyses of the skin in relation to the remainder of the flesh. Information concerning the vitamin C content of the edible portion of these fruits, at different developmental stages and at maturity, seemed desirable.

Mango fruits at various stages of development were collected from mature trees of the varieties Amini, Mullgoa, Pico, and Turpentine (native) growing in the station orchards. All fruits of each variety were collected from single trees. The erratic flowering and extended period of fruit set permitted the collection of fruits of various ages at one time, thereby minimizing environmental variables. These fruits were apportioned among five arbitrary size classes, corresponding to developmental stages from approximately five weeks after fertilization to maturity. The age of each group was determined by comparing the average fruit size with growth data obtained by measuring the size of each variety at intervals from fruit-set through maturation. The reliability of this procedure has been established through a developmental study of the fruit (4). The fruits were prepared immediately after harvest for ascorbic acid assay. Fruits analyzed for vitamin C development had the skins cut away and the flesh removed down to the husks. Composite samples of the edible portion from 10 fruits of each class of the test varieties were prepared for triplicate analyses. Ascorbic acid maps of native and Amini fruits in different developmental stages were prepared by Barnett and Bourne's (2) method to show location of this substance.

Mature fruits analyzed for location of vitamin C were collected in the same manner as the samples of the younger stages and from the same trees, except that lack of material necessitated the use of Cambodiana in place of Pico. These mature fruits were peeled and cut up. Composite samples were made of five mangoes from each variety for 1) peelings, 2) outer mesocarp, 3) central mesocarp, and 4) inner mesocarp (adjacent to endocarp). All composite samples were analyzed by the diphenylhydrazine method of

Schaffert and Kingsley (8), and the results are reported as mg/100 gm (mg %) of fresh mango flesh.

The vitamin C developmental patterns of the 4 mango varieties, Amini, Mullgoa, Pico, and Turpentine were similar. A marked decrease in the percent vitamin C of the flesh was noted between five weeks after fruit set and maturity (fig 1). Fruits of the smallest size class, average age about five weeks, yielded an average vitamin C value of 88 mg %, but at maturity (16 weeks) these same varieties averaged only 22 mg %. The greatest reduction in ascorbic acid concentration was noted between 5 and 10 weeks after fruit set. From about 10 weeks of age through maturity a more gradual decline, or none at all (Mullgoa) occurred. The vitamin C content determined for ripe Amini fruits, 11 mg/100 gm flesh, was about one half of the value reported previously; values of from 18.24 to 25.16 mg % have been recorded (6, 7). The ripe edible flesh of Cambodiana averaged less than 15 mg % vitamin C (table I) in this study, although Munsell (6) reported values of 30.52 and 37.50 for fruits of the same variety from this same orchard.

The ascorbic acid maps of native and Amini fruits showed a varying gradient from the sub-epidermal regions to endocarp. Maps made from mature fruits, although lacking the definition characteristic of the younger samples due to the decrease in vitamin C, demonstrated highest concentrations of ascorbic acid beneath the epidermis and adjacent to the endocarp. The low concentration of vitamin C in the central mesocarp tissue was confirmed by quantitative tests

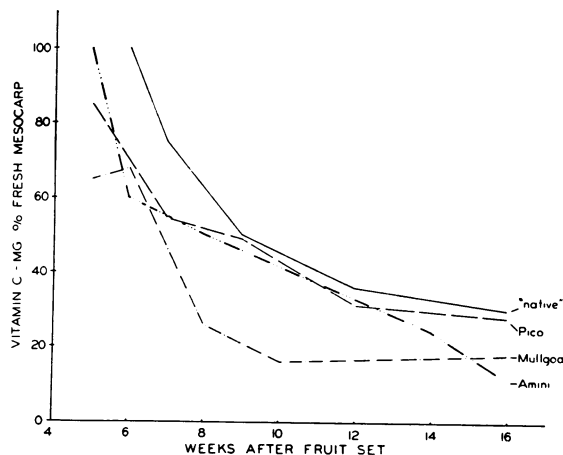


FIG. 1. Vitamin C content of the edible portion of 4 mango varieties during fruit development.

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TABLE I  
DISTRIBUTION OF VITAMIN C IN THE FLESH OF 4 VARIETIES OF RIPE MANGOES

VARIETY	TOTAL WT OF 5 MANGOES	PORTION OF FRUIT ANALYZED *							
		PEELINGS		MESOCARP					
				OUTER		MIDDLE		INNER	
		WT	VIT C	WT	VIT C	WT	VIT C	WT	VIT C
	gm	gm	mg %	gm	mg %	gm	mg %	gm	mg %
Amini .....	1095	187	22	261	15	194	10	238	12
Cambodiana .....	1532	257	28	261	20	279	10	418	10
Mullgoa .....	1669	264	26	348	11	397	16	428	20
Turpentine .....	868	118	29	176	7	211	14	217	18
Average .....	....	...	26	...	13	...	12	...	15

\* Determinations are averages of 3 replications; maximum variation among replicates was less than 2 %.

on mature fruits of Amini, Cambodiana, Mullgoa, and Turpentine. Table I shows that the vitamin C content of the peels was very similar and was the highest found, averaging 26 mg %. The layer of flesh adjacent to the husk had the next highest average, 15 mg %. The central layers of mature mango fruits, as seen from the prepared maps, contained the lowest percentages of vitamin C, averaging about 12 to 13 mg %.

Although vitamin C content of developing mango fruits has not been recorded, there are reports on the effects of maturity on such contents of full-sized fruits. Some investigators have found an increase in vitamin C with maturation (1), and others have noted a decrease (3). Mustard and Lynch (7) found that mangoes picked when beginning to show color had lower ascorbic acid contents than either fully ripe or green mangoes. No significant differences were found by these same workers for vitamin C content of the various parts of ripe mango fruits, although they noted that the flesh of each individual fruit analyzed showed a decrease in ascorbic acid concentration with increased distance from the skin.

The minimum daily requirement for vitamin C for adults is about 30 mg. Since the central layers, or the edible portion, of mango contain approximately 13 mg % of this substance, about 2 to 3 ripe fruits per day would be sufficient to meet this requirement. Ripe mangoes of the varieties studied, therefore, appear to be fair sources of vitamin C.

#### SUMMARY

Vitamin C determinations made for this study on the developing fruits of mango demonstrated a downward trend common to the 4 varieties employed: Amini, Mullgoa, Pico, and Turpentine (native). This

decrease in vitamin C concentration, from an average of 88 mg % to 22 mg %, was most marked in the period 5 to 10 weeks following fruit set; the final 4 to 6 weeks of fruit maturation was accompanied by little change in ascorbic acid concentration. Silver nitrate location maps and more refined tests by a diphenylhydrazine method showed that the highest concentration of vitamin C in ripe mangoes is not in the portion consumed. The highest concentrations are found in the peel and in the flesh adhering to the husks. The edible portion of mango fruits, however, appears to be a fair source of vitamin C.

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